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ABSTRACT

Many studies have cited the debilitating effect of math-related anxiety on achievement and vocational choice. To investigate the efficacy of cognitive behavior modification in the treatment of mathematics anxiety, 44 subjects were recruited from a high school and 2 colleges. The students were divided into two groups, a cognitive behavior modification treatment group and a waiting control group. As expected, the treatment group showed a significant decrease in mathematics anxiety. Their monitoring of negative self-statements and relaxation apparently was successful, although adolescent boys had difficulty relating to the relaxation and imagery process. The results also suggested a profile of the typical math-anxious person, i.e., a female with less parental encouragement to study mathematics and a less-educated mother. The findings indicate that programs designed to deal with the problem of mathematics anxiety, however, need to be addressed to both sexes. (Author/JAC)

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Reduction of Mathematics Anxiety: A Cognitive Behavior Modification Approach

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Introduction

As early as 1954, Gough delineated a condition she labeled mathephobia and sought to describe its causes and treatment. Others began to study this phenonmenon (Aiken and Dreger, 1957; Chanskey, 1966; Ernest, 1976; Fox, Fennema and Sherman, 1977, Naylor and Gaudry, 1973; Neale, 1969; Tobias, 1978a, 1978b, 1980, 1981; Webb, 1972; Silverman, Creswell, Vaughn and Brown, 1979) and to recognize its significance to the population at large. While it appears that gender offers no immunity to the distress suffered by the math anxious, Tobias (1981) continues to view mathematics as a "filter" which serves to prevent many otherwise capable and talent individuals (especially women) from entering math related fields. Additionally, math avoidance prohibits promotion and advancement to managerial and administrative positions which necessitate the use of statistical and numerical data.

For many years, awareness of math anxiety and its ramifications was limited to educators and mental health professionals. More recently, the public has become alerted to its existence and impact in many popular publications ranging from Vogue Fashion Magazine and The Wall Street Journal to cartoons such as the Peanuts series. This increasing awareness on the part of professionals and the general public has led to efforts to deal with the problem. Various methods of treatment have been utilized. The majority are based on a combination of behavior modification and training in mathematical skills and concepts. The process of systematic desensitization is a common component (Hyman, 1973; Natkin, 1967; Richardson and Suinn, 1972; Suinn and Richardson, 1971). These researchers have shown that this type of treatment has been effective with many people. However, for those who do not respond to this procedure, there has been little hope of overcoming their problem.

A considerable body of knowledge regarding the efficacy of desensitization has accrued over the past 15 years (Bandura, Blanchard, and Ritter, 1969; Barrett, 1969; Katahn, Strenger and Cherry, 1966; Lang, Lazovik, and Reynolds, 1965; Paul, 1967, 1969; Rachman and Hodgson, 1967). However, in their studies of standard desensitization, Johnson and Sechrest (1968), Lang et al. (1965), Meichenbaum (1972a), Weinberg and Zaslove (1963), and Wine (1970) have found that while debilitating anxiety decreased, there remained a level of anxiety that could be viewed as facilitating performance. The use of this facilitative anxiety has been made a component of cognitive behavior modification. Cognitive behavior modification has also been adapted to utilize the techniques of modeling, mental rehearsal of

adaptive behavior via coping imagery and attention to the covert mental process of the client in an attempt to accomplish greater behavioral change than desensitization alone appeared to achieve. Cognitive behavior modification has been successfully applied to other anxiety related conditions (Meichenbaum, 1971, 1972b; Weissberg, 1977; Weissberg and Lamb, 1977; Wine, 1970). However, the multimodel treatment developed by Meichenbaum (1972b) had not yet been applied to mathematics anxiety. Thus, the intent of this study was to investigate the efficacy of cognitive behavior modification in the treatment of mathematics anxiety as well as to assess what other variables were associated with the higher levels of that anxiety.

Procedures

The subjects (n = 44) for this study were volunteers recruited from a two year college, a four year college and a senior high school located in central California. All subjects considered themselves to be mathematical anxious and ranged in age from 14 to 58 years. Subjects were equally divided between the cognitive behavior modification treatment group and a group awaiting future treatment (control).

The subjects' pre and post levels of mathematics anxiety were measured by the Mathematics Anxiety Rating Scale (MARS) developed by Richardson and Suinn (1972). The MARS is a 98 item rating scale composed of short descriptions of behavioral situations. Subjects respond from "not at all anxious (1)" to "very anxious (5)" to situations such as "figuring the sales tax on a purchase that costs more than $1.00" and "reading the word statistics". Evidence for reliability and validity of the test are found in studies by Richardson and Suinn (1972) and Suinn, et al. (1972). The scale showed a negative correlation with the Differential Aptitude Test (mathematic section) and positive correlations with the Taylor Manifest Anxiety Scale, and measures of social anxiety. Each subject also completed a demographic data sheet with the variables of age, education, marital status, sex, race, number of years of schooling for self and parents, grade and conditions of onset as well as present experiences of mathematics anxiety, major and minor fields of study, degree of worry about mathematics, and parental and other encouragement/discouragement to study mathematics.

The treatment was based upon Meichenbaums' (1972b) cognitive behavior modification approach. However, based on research on accelerated massed desensitization (Robinson and Suinn, 1969; Suinn and Hall, 1970; Suinn, 1975), subjects

met twice per week for four weeks.

Treatment sessions lasted 60 minutes each with the exception of the first and last, which required an additional 45 minutes for completion of the instruments. A 20-minute relaxation tape was distributed to each person in the treatment groups at the initial session. The purpose of the tape was to provide the subjects with structure in the at-home relaxation practice in the absence of the researcher. After completion of all instruments at the first session, a discussion was held regarding the nature, function and importance of negative self-statements. The subjects were asked to monitor their own self-statements in any mathematics related situations encountered so as to be able to discuss these at the second session. Participants were then introduced and guided through the relaxation exercise and dismissed.

During the second and third sessions, subjects were taught how to construct their own desensitization hierarchies which were subsequently utilized as part of the treatment sessions as well as for practice at home. During the third session, copies of examples of coping self-statements were distributed in order to stimulate a discussion and to elicit similar statements appropriate to each individual participant.

From the second through the eighth session, experimental subjects were guided through the relaxation process and asked to imagine successive scenes on the self-constructed hierarchies. Each was told to proceed at her/his own pace in terms of not advancing to the next higher anxiety arousing situation on their list until a steady level of relaxation has been attained on the lower level situations. The subjects were given the homework of continuing to practice this entire procedure between sessions. At each session, discussions were held concerning successes and problems encountered. The purpose was to provide reinforcement and to utilize successes as a model for others in the group. Additionally, these discussions allowed the researcher to identify and attempt to ameliorate misconceptions and procedural difficulties.

Results

Two separate procedures were utilized to answer the two research questions. First, an analysis of covariance ascertained the degree to which the groups changed after considering the effects of the pretest. Secondly, a multiple regression analysis was used to relate math anxiety to a series of questions about the development of that anxiety.

Table 1 shows the pre and post MARS scores for the two groups. The analysis of covariance revealed a significant difference in the groups ($p < .05$) after the effects of the pretest were controlled. The pre and post measures were correlated .47, and the magnitude of effect of the treatment (eta^2) was .07. As seen in table 1, both groups decreased in mathematics anxiety (the waiting group dropping 13 points and the treatment group dropping 43 points). However, there was still a rather large standard deviation in the treatment group.

Table 2 reveals the results of the stepwise regression analysis. Entry level anxiety (pre MARS) was related to a series of questions regarding the development of mathematics anxiety. As shown, participants with higher math anxiety were more likely to: worry about mathematics, be female, had less parental encouragement to study mathematics, and had mothers with fewer years of education.

Discussion

As hypothesized, the results showed a significant decrease in mathematics anxiety favoring the cognitive behavior modification groups. The monitoring of negative self-statements and relaxation apparently obtained their desired effect. It should be noted that during the sessions, seven of the treatment group and eleven of the control group were enrolled in required mathematics courses. Eight treatment group and eleven control group subjects were enrolled in elective mathematics courses. Although significant, the magnitude of effect was modest in part due to the high level within group variability (especially in the experimental group). Knowledge regarding the variability in the treatment group emerged from the group discussions and the researcher's observation of participants during sessions. Several members of the treatment groups admitted that they did not practice their relaxation and coping skills at home. This practice was considered an integral part of the treatment. The only work these subjects did was during the treatment sessions and some did not appear highly motivated even then. When their MARS were scored, it was noted that these same subjects actually had higher raw scores at the end of treatment.

Although ages ranged from 14 to 58 years, 10 (45%) of the treatment subjects were between 14 and 19 years of age. This time of life is not noted for its stability. There are many other needs and issues that tend to be more pressing for this age group than the amelioration of mathematics anxiety

(Gould, 1972). The older participants in the treatment group reported seeing a much greater need to deal with and overcome their mathematics anxiety. This subjective report appeared to be supported by the data of this study. The finding here was that the teenagers were at the lowest mean levels of mathematics anxiety of all age groups, with those in their 20's have the highest levels, followed by those in their 30's and 40's respectively. These latter subjects were also able to cite concrete and immediate reasons for overcoming their math anxiety.

Another observation of the treatment group was that the adolescent boys had difficulty relating to the relaxation and imagery process. Several apparently became embarrassed about closing their eyes, tensing and releasing various muscle groups, and then imagining the anxiety provoking situations. They would grin and suppress giggles as the relaxation and imagery instructions were given. It may be that adolescent males are more action oriented and that progressive relaxation and imaginal process are to passive for them and that other anxiety arousing issues arise in that state. It may be that working individually would be less threatening than working in a group of peers.

Those who admitted worrying about mathematics had higher levels of anxiety on the MARS pretest than those who did not. This finding concurred with Tobias's (1978, 1980) and Meichenbaum's (1977) views that self-defeating, self-statements play an important role in arousing and perpetuating anxiety related to mathematics. The recognition of their worry did have the reported effect of using this concern constructively in the change from negative to positive self-statements as well as in the rehearsal of coping strategies by the subjects in this study. Both of these are important elements of the Meichenbaum (1972b) cognitive behavior modification program. Feedback from the subjects during the treatment process regarding the usefulness of these two coping techniques lent subjective support to their efficacy.

Higher levels of mathematics anxiety were demonstrated by females in this sample, which added further support to previous research (Ernest, 1976; Fox et al., 1977; Tobias, 1978, 1980). Eleven of the 44 sujbects were male. This suggested that gender did not provide immunity to mathematics anxiety. It was also clear that programs designed to deal with this problem need to be addressed to both sexes.

Maternal education also had an effect with the trend being that the more educated the mother, the less anxious the subject. This finding agreed with research done by Hinders in 1977. Apparently, mothers who value education enough to continue their own training provide role models for their children to follow. These mothers also allow for direct contact with someone who must overcome whatever barriers exist to their pursuits. This has the potential for demonstrating to their children what can be done and for providing support to children in their endeavors. The potential is also present for the defusing of sex-role stereotyping in which only males strive to achieve in technical and scientific fields.

As has been found in other studies (Aiken, 1970, 1972; Fedon, 1972; Fox, 1976; Iams, 1977; Poffenberger & Norton, 1956; Smead, 1977), parental attitudes play a significant role in the life of the mathematics-anxious person. Although they still experienced anxiety, those subjects whose fathers and mothers encouraged them to study mathematics were less anxious than those whose parents did not provide encouragement. While there was little outright discouragement from parents, neutral or indifferent parental stance toward the study of mathematics may serve to heighten anxiety. Failure to encourage may thus have as negative an impact as actual discouragement.

Table 1

Means and Standard Deviations of Pre and Post MARS by Groups

	Pretest			Posttest		
	n	Mean	SD	n	Mean	SD
MARS						
Control	22	266.68	70.94	22	253.54	76.07
Treatment	22	277.22	57.69	22	233.72	52.91

Table 2

Multiple Regression Analysis of MARS Pretest by a Series of Independent Variables

	Simple r	Multiple R	Multiple R^2
Worry about mathematics (yes = 2, no = 1)	.375		
Maternal education (years)	-.272		
Sex of subject (male = 1, female = 2)	.289		
Maternal encouragement to study mathematics (yes = 2, no = 1)	-.298	.687	.472*
Paternal encouragement to study mathematics (yes = 2, no = 1)	-.166		

*$p < .05$ (other variables added little in terms of explaining variability in the MARS Pretest)

Coping Self-Statements

Confronting and handling the stressor of doing math

What is it I have to do? No negative self-statements.
Just think rationally.
Don't worry; worry won't help anything.
Focus on the task; exactly what does the problem really ask?
It doesn't say this . . . or this . . . it just asks . . . .
Just think about what I can do about it. That's better than getting anxious.
Don't look for tricks, just what do I do?
I don't want to get lost in detail; stand back and look at the big picture.
That's a stupid problem. O.K. It's stupid, or I don't get the point. I'll come back to it.
Wonder how many I can miss for a B . . . I'll figure that up later; just pay attention and finish this up.

Coping with the feeling of being overwhelmed

Don't get anxious; just take off a moment and take a couple of slow, deep breaths---calm---and relax---good.
Don't try to eliminate the anxiety totally; just keep it manageable.
Keep the focus on the present; what is it I have to do?
Lots more to do before I finish. Just take one problem at a time.
This is the anxiety that I thought I might feel. It's a reminder to me to cope.
Slow down a little; don't rush and get all in a panic . . . there's time to do it.
I'm not going to be able to do it. I'm going to lose control. No, take a deep breath, part lips, relax.
Label my anxiety from 0 to 10 and watch it change.
Now, I'm under control--back to the problems.

Reinforcing self-statements

It's working. I can control how I feel.
Wait until I tell my group about this.
I am in control. I made more out of my fear than it was worth.
My blasted ideas; that's the problem. When I control them, I control my fear.
It's getting better each time I use the procedures.
I did it!!!

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